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ABSTRACT

System analysis offers the teacher a significant organizational device for studying society and social problems in the classroom. System analysis can be used directly to describe and understand the relationships and interactions between individuals, bridging the distance between learning conceptually and learning directly from personal experience. Another pedagogical advantage of the system approach is that it can be taught in its own right as subject matter, or it can be used as a vehicle for producing greater understanding of matter taught in history, sociology, etc. The fundamental characteristics of a system, representing the interaction of two or more parts, are goal- or non-goal-orientation; mechanical, social, and natural types; the functions of detecting, selecting, and effecting; intrasystems; intersystems; communication and transaction capabilities; and change and equilibrium. These characteristics, diagrammed and applied to the concepts of family and poverty and to ecological problems illustrate use of the method. Numerous examples of elementary level classroom activities exploring the characteristics of system ideas and relating system concepts directly to student's daily lives are also included in this document. (JH)

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SYSTEM ANALYSIS AND ITS USE IN THE CLASSROOM

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Boulder, Colorado 80302

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FOREWORD

One of the major functions of the Social Science Education Consortium is to develop the fundamental ideas of each social science discipline in ways that will make them useful for curriculum purposes. In 1964, with the help of a grant from the U.S. Office of Education, a group was formed to work on this task, under the direction of Lawrence Senesh, then Professor of Economics at Purdue University. In addition to Senesh, the group included David Easton, Professor of Political Science at the University of Chicago; Paul Bohannan, Professor of Anthropology at Northwestern University; and Robert Perrucci, Professor of Sociology at Purdue University. In the following two years, structures of the four disciplines represented by this group were developed and published. Today these structures are the foundation of social science curricula in many school systems throughout the country.

In 1969, a small conference supported by the National Science Foundation was convened by the SSEC to explore the possibility of defining the fundamental ideas of system analysis in a way that would relate them both to the structures of social science disciplines and to the K-12 curriculum. This work was also under the direction of Lawrence Senesh, now Professor of Economics at the University of Colorado. Major contributors to that conference, in addition to Senesh, were Professor Kenneth Boulding, of the University of Colorado, and Professor Alfred Kuhn, of the University of Cincinnati, both pioneers in the development of system analysis. Others who made useful contributions to the conference included several SSEC staff members and three graduate students--James Hodges and Richard Van Scotter, of the University of Colorado, and Susan Kellar, of the University of Cincinnati.

The staff working on this assignment found that system analysis offers a significant organizational device for studying society and the social problems faced by society. Looking upon society or any part of it as a system helps the teacher and the student see certain relationships which conventional analysis does not reveal. System analysis does not replace the analytical tools of the social sciences, but may permit restructuring them for greater clarity and insight.

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This paper, having gone through many revisions, is an outcome of the work begun in 1969.

Irving Morrissett
Executive Director
Social Science Education Consortium
May 1975

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SYSTEM ANALYSIS

AND ITS USE IN THE CLASSROOM

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1.0 INTRODUCTION

In recent years, "system analysis" has become something of a household word. The system analytic approach has been employed in an ever-increasing variety of fields, from business to scientific research to education. The authors of this paper believe that system analysis can provide adults and children with a powerful set of intellectual tools and hope to encourage introduction of system concepts early in the educational experience. Thus, the paper has been developed to help teachers begin to introduce system analysis ideas in their classes at as early a level as possible.

1.1 Historical Development of System Analysis

Until about World War II the "hard scientists"--physicists, chemists, astronomers, geologists, and the like--insisted that "science" dealt only with antecedent causes. The notion of a goal as part of an explanation of anything was viewed as utterly unscientific. Social science was considered "soft" science, as was individual psychology and, to some degree, biology. Social scientists faced the dilemma of including the idea of goals in their explanations, which left them feeling distinctly unscientific, or of leaving

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out goals, which left them feeling very unhuman and unsocial. Watsonian stimulus-response psychology was one of the efforts that sought to make the soft sciences as rigorous as the hard ones. Its method was to follow the hard sciences by leaving goals out of the picture entirely, in marked contrast to much other psychology before and since. This hard-headedness was probably useful at that moment in the history of psychology, though the barren result left psychology in need of much supplementation.

The decade immediately following World War II brought a sharp change in this thinking. The study of cybernetics by Norbert Wiener and the pioneering efforts of von Bertalanffy, Boulding, Rapoport, and others in the area of general system research bridged this seemingly impassable gulf. The conceptual device was the controlled, or cybernetic, system, reflected in such "hard science" devices as the guided missile, the thermostat, and the self-regulating steel rolling mill that automatically adjusted the distance between rollers when it detected a deviation in thickness of the finished product. The computer that "wanted" to win a game of chess was the relatively soft intermediary between the human sciences and the harder devices that "preferred" or "sought" a particular target, temperature, or thickness of steel.

1.2 Uses of System Analysis

System analysis is thus a major conceptual invention that paves the way both for tighter scientific analysis of human and social behavior and for important moves in the direction of unified science. The materials in this paper try to show how the system view can be used to tie together the various social sciences, to relate the societal realm more explicitly to individual psychology and to natural sciences, and to reduce the number of concepts required to deal with the spectrum of the social sciences. The chief reason why the conceptual set can be simplified, and greater efficiency achieved, is that many generalizations or propositions about systems are valid without regard to the superficial type or level of the particular system involved. The system view, for example, indicates that in important ways the diagnosis of the behavior of Jerry Jones can be analyzed with the same conceptual tools as can the behavior of General Motors, insofar as General Motors acts as a coordinated unit. Similarly, the interactions between Jerry and Mary can in important ways be analyzed with the same conceptual tools as can the

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interactions between General Motors and Republic Steel, or between the United States and Russia.

As indicated by the examples just given, the system approach applies equally to the behavior of a single system acting in an environment and to the interactions of two or more systems. **Intrasystem analysis**, focusing on a single system, might be thought of as behavioral science and **intersystem analysis**, dealing with interactions of two or more systems, as social science. These two key terms--**intrasystem** and **intersystem**--are fully discussed in the following sections. In this paper it is assumed that the interaction of two or more systems cannot be analyzed without attention to the nature and states of the interacting units and to their effects upon one another. Although intrasystem activity and intersystem activity can logically and definitionally be isolated in the system approach to social science, both are part of a single, integrated explanation. For purposes of this discussion we will therefore refer to the study of the two together simply as "social science," or as the "science of social systems."

A person who uses system analysis should be aware that it is up to the observer-analyst to determine whether something is to be viewed as a system, with interacting components, rather than as a "lump," and where the boundaries of it are to be set. For example, to the ecologist the surface of the earth is a highly complex and fascinating system; whereas to the astronomer who is concerned solely with its mass, velocity, and orbit the earth is simply a "lump." However, the earth as a "lump" is nevertheless a component of the solar system, which is the system of interest to the astronomer. Similarly, the observer decides for himself whether he is interested in a whole human being as a system rather than in his circulatory system or in the family or corporation of which he is a member.

While the analyst's choice of boundaries of the system he studies is to a large extent arbitrary, the wise observer will nevertheless give attention to certain kinds of boundaries which are influenced by nature; he will "carve his systems at the joints," not through the middle of a bone. For example, the biological individual has boundaries that are well defined by nature, and the solar system is also easily isolated from other astronomical entities. In short, the observer-analyst has wide discretion in deciding what he will or will not view as a system; but he should not ignore the traits of nature which make it useful to view some collections of things as systems and

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others not.

1.3 Use of "System Analysis" in This Paper

This paper uses and illustrates mainly the pure, or polar, cases of system analysis and its elements. Most of reality, of course, consists of complicated mixtures. Our concepts and perceptions are often strongly shaped by our motives. That is, our cognition is influenced by our affector--and vice versa. Similarly, every communication of information has some valuational aspects and every exchange of valued things has some informational aspects. But for the same reasons that in physical science we teach how free-falling bodies behave in a vacuum before we deal with their rates of fall through the real and gusty atmosphere, so in social science our understanding will become sharper if we deal first with the relatively simple pure cases before we proceed to their complex mixtures.

The term "system" is widely used in many different ways at present, mainly because the science of system analysis is still young and unstandardized. The literature also displays numerous ways of classifying and categorizing different kinds of systems. Among other things, the term is often applied to analytical systems like mathematics, to languages, and to theoretical structures. Hence we have the somewhat bizarre and confusing usage in which the theory about systems is also referred to as a system. This document will avoid that difficulty by using the term solely in connection with real, acting systems. By this we mean systems that have weight and occupy space, like human beings and automobiles, and which do something by movements of matter or energy, like kicking footballs and running off highways. Even thinking, of course, involves some movement of matter or energy in the brain, and so do seeing and hearing. These may be contrasted with pattern, or non-acting, systems--like a language, mathematics, and a theory--whose parts are in some sense consistent within the criteria of some acting system, but which do not themselves do anything.

Another note on usage of terms may be helpful at this point. In the literature "system analysis" is used more or less interchangeably with "systems analysis." In this paper we will stay consistently with the singular.

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1.4 Using System Analysis in the Classroom

Only the barest introduction to basic system analysis concepts can be presented in this paper.* However, the enterprising teacher can nevertheless get a reasonable overview of such an approach, and, with the help of the classroom activities included in Section 5.0, do significant teaching using this conceptual framework.

Because the primary purpose of the document is to help teachers begin to introduce system analysis ideas at the early levels, suggestions for classroom activities are made with elementary grades in mind. However, individual teachers will need to experiment to discover what works best for their students, bearing in mind that activities can be adapted upward more easily than downward.

An important pedagogical advantage of using the system approach is that it can be taught in its own right, as subject matter content, or it can be used as a vehicle for producing greater understanding of materials that are taught in other connections, including courses in history, civics, problems of democracy, economics, sociology, anthropology, and human geography. Perhaps of even greater importance for the contemporary trend in social studies education, this framework can be used directly in describing and understanding the relationships and interactions between pupil and pupil, pupil and teacher, pupil and parent, teacher and principal, school board and citizenry, and so on. Hence this approach makes it possible to bridge

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*Alfred Kuhn, The Study of Society: A Unified Approach (Homewood, Richard D. Irwin, Inc., 1963) contains most of the background that would be needed for one who wants more information than is included in the present paper. Since much of this paper is based on the work of Kuhn, subsequent writings advancing the work started in The Study of Society should be mentioned here. One, tentatively entitled Social System, is written for specialists; the other, tentatively entitled Social Science, is written for college freshmen. The latter is scheduled for publication by Richard D. Irwin, Inc. in the spring of 1974, and is to be accompanied by a workbook. In both publications, the approach is much more explicitly system-based than in the initial volume. Both are more comprehensive in scope, covering sociological and political materials, in particular, more explicitly than before. Both are also more efficient than the original, in the sense of further reducing the total number of distinct concepts and of tying their definitions together more explicitly. The Kuhn approach in turn derives its inspiration and background from the many works of Kenneth Boulding, and from those of numerous other system analysts and social scientists.

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that sometimes vast distance between those who feel the student must learn some kind of conceptual structure and those who are convinced there will be no "social" learning except that which arises directly from the student's personal experience in his interactions with others. For the same reasons it can be used to facilitate understanding for those students who participate directly in various community activities, or who make a cooperative, community venture of the learning process itself. The imaginative teacher can induce these understandings from students after saying, "Now let's talk about what we have been doing, and about what has been going on here in this classroom." Given sufficient insights by the teacher, the individual and social aspects of the learning process itself can be conceptualized in this way, so that there is an important merger of the learning process and the things learned.

The teacher's discretion should determine whether the systems language ought to be used directly, in contrast to the ordinary language parallels--for example, whether **knowing**, **wanting**, and **doing** should be used instead of the more formidable-sounding **detector**, **selector**, and **effector**. This document uses the formal terms to make sure their meanings will be clear to the reader.

1.5 Organization of the Paper

This paper is divided into five major parts. Following this introductory section, Section 2.0, **Fundamental Ideas of System Analysis**, sets forth the conceptual framework of system analysis. Section 3.0 contains a diagram of the major concepts of system analysis and their interrelationships. (The reader may want to peruse this diagram before reading Section 2.0, in order to get a quick overview of system analysis.) Then, Section 4.0 describes three applications of this framework, to the study of the family, of ecology, and of poverty. And, finally, Section 5.0 consists of a wealth of suggestions for teaching activities using system analysis.

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2.0 FUNDAMENTAL IDEAS OF SYSTEM ANALYSIS

2.1 What Is a System?

A system is composed of two or more interacting parts. For instance, a pair of scissors, a human being, an ant hill, an automobile, or a seesaw may be thought of as a system. A system may be distinguished from its environment--what surrounds the set of interacting parts; and it may or may not interact with its environment or with parts of it.

A man is a system with many needs which he tries to satisfy by interacting with his environment, through the operation of his own and other systems created either by nature or by man. Some needs are unlearned, such as the need for food and warmth. Others are learned, through thoughts or actions of the individual or through interactions with other persons; for example, the need for Picasso paintings or fast sports cars is learned.

2.2 Goal- and Non-goal-oriented Systems

Systems can be either goal oriented or non-goal oriented; that is, there are systems that act in order to fulfill certain objectives, while others exist without any particular purpose or goal. For example, a business is a goal-oriented system, since it has a purpose--earning a profit. An electric refrigerator is a goal-oriented system, since man builds into it the "goal" of maintaining a constant temperature. A fish is a goal-oriented system since it wants to eat in order to stay alive. A plant is a goal-oriented system because its parts interact to keep it alive. All living things, including man, are goal-oriented systems.

On the other hand, a pond is a non-goal-oriented system. All of its parts, such as plants, fish, and bacteria, interact. However, they do not interact together to achieve a common goal or purpose; rather, each part acts independently to achieve its own goals. Another non-goal-oriented system is the market where buyers and sellers meet. Depending on supply and demand, the prices go up or down; but the market itself does not "care" whether the prices are high or low.

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2.3 Man-made Systems

Man, a goal-oriented system, creates other systems outside himself to help him satisfy his needs and achieve his goals. These systems may be goal oriented or non-goal oriented. To be goal oriented, the goal or preference must be in the system itself, not in the person who uses the system.

Some of the systems man creates are **mechanical**. Like all other systems, mechanical systems combine parts, as in a motor, a wagon, or a refrigerator. An example of a goal-oriented mechanical system is a thermostat or an "automatic pilot" in an airplane. An example of a non-goal-oriented mechanical system is a pair of pliers or a tractor.

Other systems created by man are **social**. A social system combines the actions of two or more persons, as in a family, a business, or a government. These are higher level systems than the individuals that compose them, and are called **organizations**.

Man has also modified existing **natural systems** to create new systems through such activities as plant and animal breeding and other changes in the natural environment.

2.4 Intrasystem Analysis

Man and all other goal-oriented systems achieve their goals by the interaction of their parts, that is, **intrasystem activity**. This activity may be analyzed into the functions of detecting, selecting, and effecting..

2.41 **Detector, selector, and effector.** The steps through which a system moves in achieving its goals are (1) receiving and acquiring information about its environment and the consequences of the system's actions within that environment--the **detector** function; (2) evaluating the information and selecting the preferred alternative for action--the **selector** function; and (3) putting into effect the selected alternative to meet the goal--the **effector** function. For man, these steps may be thought of as knowing, wanting, and doing.

After the selected alternative has been put into effect, the cycle starts anew, to maintain or modify the results of the action. The system detects information about the changed state of the environment as a result of its actions; it selects a possible new preferred alternative on the basis of its evaluation of this new information; and it puts the preferred alternative into effect, to preserve the goal achieved, to come nearer the original goal, or to meet a new modified goal. This process goes on and on.

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2.42 Learning. The concept of learning plays an important role in system analysis, especially when system analysis is applied to people and to social systems. Learning can be defined simply as some change in a system which alters the relation between its input of information and its output of behavior. After a system has experienced learning, a given input of information from the environment leads to a different response from the one that same input would have produced before the learning took place.

A system can learn new knowledge and new ways of receiving and processing information. It can also learn new motives or goals, and new skills. That is, changes in a system can take place in its detector, selector, and/or effector states; any such change not brought about by biological maturation is called learning.

Among various kinds of systems the ability to learn varies from none to very high. In insects and plants, for example, the ability to learn is small or nonexistent. A living system that cannot learn survives solely through input-output relations which are "imprinted" in it by its genes. The broad goal of such a system is survival, although it achieves that goal through related sub-goals, such as acquiring food, excreting waste, and avoiding extreme temperatures and pressures.

Human beings and some animals have a high ability to learn. These systems, particularly humans, have broad capabilities for modifying their goals, as well as for modifying their means of receiving and processing information and their methods of bringing about changes in their environments. Learning ability in man is so great that he can learn new goals which have little or no direct relation to survival, such as art and music, automobile racing, and growing flowers. Man's goals are thus many and varied.

The unique characteristic of man is that much of the information that enters his brain is organized into conscious or unconscious images. In this form the information constitutes knowledge. These images differ from person to person and from culture to culture. A man's images can include information about his environment, about his goals, and about his skills and abilities. In any one person these images are the product of his whole past experience, including what he has learned as part of his culture. An image is a sort of mental "map" that helps a person "find his way" among the things he thinks about and his experiences. These mapped images are often challenged by new information. Old information may then be subdued, and the shape of a new image will emerge.

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Common usage often attaches a positive normative judgment to the concept of learning--that is, learning is "good." For the system typically considered, the definition of learning is neutral; it does not assert that learning is either good or bad. But neither does it preclude the possibility of defining some kinds of learning as good and others as bad.

2.5 Intersystem Analysis

Just as parts within a single system interact, so also can systems themselves interact with each other. As mentioned earlier, in Section 2.3, individual men are the systems which combine to form larger systems--organizations and even whole societies. The interaction between two or among several systems--individuals or organizations--can take place through **communications** or **transactions** or both. The terms communication and transaction both deal with the transmission of something from one system to another system.

2.51 **Communication.** **Information** is transmitted by communication. Communication originates from a distinguishable **source**; for example, a citizen with an idea. This idea--the information--is subsequently **encoded** into a **medium**--the citizen puts his idea into the written form of a letter. The medium is **transmitted** from source to **receiver**--the letter is mailed and delivered to his Congressman. The **message** is **detected** by the receiver--the Congressman reads the letter. Finally, the message is **decoded** by the receiver--the Congressman attaches meaning to the letter, which may or may not resemble the meaning intended by the source. If any one of these steps is ineffective, the communication will not be clear.

In system language the term communication refers to any **transfer of pattern**. Such a transfer can be very simple and direct, as in the transfer of the pattern of a tire tread into mud or of a fingerprint into a police file. Social scientists are interested almost exclusively in more complex **mediated** transfers, which have one or more intermediate steps. A simple physical example of mediated transfer is the transfer of the shape of a mammoth's foot into mud, which, after geological hardening, may be transferred again to a plaster cast for a museum. In photography, the pattern of a landscape is transferred into a pattern of silver particles on a film, negative, which is retransferred into a second pattern on a positive print.

Among humans we are interested in patterns that start in the head of

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one person and are transferred to the head of a second person. Since we know of no way by which one brain can put information into another brain by direct contact, all communication between humans is presumably mediated. In its barest minimal form, a pattern or image in one head is reproduced externally in some overtly observable form, as when a potter makes a vase. That external form is observed by another human and becomes an input to him, after which a similar pattern or image exists in the head of the second person. In saying these things, we do not imply that we know what form a pattern takes inside a head--as, for example, whether it consists of nerve networks, synaptic connections, chemical states, or wave forms. We merely presume that a particular pattern has come to exist in the head of a person if he can himself produce some external representation of it.

Pattern transfers are of two main types. The first can be called isomorphic, unconceptualized, or uncoded. Isomorphic means that there is some kind of one-to-one correspondence between one pattern and a reproduction or transformation of it--as between actual roads and the pattern of them as represented in a road map, or between the wiggly grooves in a record and the pattern of sound when the record is played. Unconceptualized means that we are dealing with an "original" pattern, not the concept or mental image of it in someone's head. Uncoded means both unconceptualized and unnamed--that we have not attached a name to the pattern or have not represented it by a word or other sign.

The second, or coded, type of pattern transfer means both that we have conceptualized the pattern (our concept of dog, as contrasted to the real dog) and that we can communicate about it by means of signs or language, if we construe "sign" and "language" broadly enough to include nods, gestures, facial expressions, tone of voice, position and stance while speaking, and all the other ingredients of conscious and unconscious symbolic representations. In contrast to the more direct non-sign pattern transfer, this second type of communication includes a **message**. Examples of coded patterns are written messages, verbal instructions, and turn signals on automobiles.

2.52 Culture as communication. Culture is a particular type of pattern transfer. It is defined as communicated, learned patterns, and is a straightforward communication phenomenon. The process of culture is the transfer of patterns from one person to another, either by imitation or by messages, with special emphasis on the transfer from one generation to the next. The

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content of culture is the total set of such patterns thus transferred in a society--again with emphasis on the body of patterns held by more or less the whole of a society and transferred from generation to generation. The main kinds of patterns thus possessed and transferred within a society can be classified as (1) artifacts, such as tools, utensils, clothes, buildings, and art objects; (2) sociofacts, such as structures and behaviors of families, governments, firms, and economies; (3) performance skills, such as techniques of doing or making various things; and (4) concepts and language.

The content of the culture includes valuations attached to many of these patterns, as reflected in expressions of good and bad, pride and shame, approach and avoidance, and the like. In the broad sense, a communication is a transfer of information, or pattern, from the head of one person by means of some external reflection or representation of it executed by his effectors, to the detector of another person. A communication does not cease to meet this definition when the pattern transferred also has a value content to the extent of arousing strong emotion. For example, the massive affective states which may be set in motion by the words, "I love you," come only after and if the cognitive meaning is clear, as we can see from the absence of a similar response to the words, "Je t'aime," spoken to one who understands no French.

When, why, and the extent to which a given communication will be clear is a long and complicated question which depends on many factors, including speed and skill in learning. However, the main prerequisite for accurate sign communication is that the sender and the receiver of a message possess the same set of signs and referents. That is, they must have the same words in their vocabularies, attach the same meanings to each, and accept the same grammatical rules. In a broad sense these conditions are met by persons who share the same culture or subculture. The absence of such conditions, in whole or in part, helps to explain why cross-cultural communications--for example, communications across those particular subcultures known as academic disciplines--are often unclear.

2.53 **Transaction.** The interaction among two or more systems can take place through a transfer of valued things as well as through a transfer of information. Valued things are transferred by **transactions.** Whereas communications are viewed as interactions analyzed with respect to their information (or pattern) content, transactions are interactions analyzed with respect to their value content.

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There are three types of transactions. **Selfish transactions** are those in which the parties are concerned only or primarily with their own welfare--as in buying and selling--and are indifferent to the welfare of the other party. **Generous transactions** are those in which one party is motivated primarily by concern for the other party's welfare, as in giving a gift. A **hostile transaction** is one in which one party tries to hurt another, even though the action may also hurt the doer, as in maintaining a boycott.

Among families and friends, generous transactions are often found. If parents did not give many things generously to their young children, the children could not survive. Transactions which are neither generous nor hostile, and which we simply call selfish, are common between businessmen and their customers, among people in political offices, and among nations.

The outcome of a selfish transaction between two systems depends on **power** and **bargaining power**. Power between persons is the ability to get something from another person. **Bargaining power** is the ability to get it on good terms. Both power and bargaining power depend on how strongly each party wants what the other has and how strongly he wants to keep the thing he must give in return. Both may be influenced by imposing or threatening to impose harm. Harm actually imposed, which can be relieved if the other party does as one wants, is called **stress**. Harm that is threatened, but that will not be imposed if the other party does as one wants, is simply called **threat**. For example, the relationship between husband and wife may be influenced by the implicit or explicit threat of divorce, the negotiations between two nations may be influenced by the threat of war, and labor-management relations may be influenced by the threat of a strike. All power and bargaining power over others lies in being able to give them something they want, in the form either of providing something positive or of removing something negative. While there are many complications and variations, this general rule always applies.

In any transaction, how much each party must give up to get valued things from the other party is called the **terms of trade**. In every organization, from the family to the nation, the different members of the organization trade on different terms, depending on their power and bargaining power. If a person (or group) feels that the organization doesn't offer him fair terms of trade, he will feel badly about the system, or feel hostility against it. This is one reason why families break up, why neighborhoods turn against the city, and why some people may give up citizenship and leave the country.

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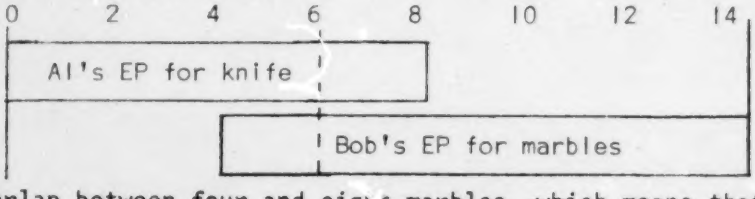
People do not like giving up things they like without getting something else they want in return. Hence, they often "gang up" on persons who use stress or threats to bargain things away from them. Such ganging up by those who are being threatened is called a **coalition**. Sometimes people form a permanent coalition of persons to stop anyone who tries to use stress or threats against them. In many societies the police perform this job. If police are used this way, it is usually with the understanding that they themselves operate under strict rules.

It should be noted that there is no transaction without some communication, and there is no communication without some transaction. That is, every communication is in part a transaction and every transaction is in part a communication. The quality or accuracy of communications and the terms of transactions between two systems are influenced by each party's knowledge (detector), by each party's comprehension of its own goals (selector), and by each party's ability to put into effect its preferred alternatives (effector).

2.54 **An Illustration of a transaction.** This illustration of the transactional process will help to clarify a fundamental aspect of transactions--their terms of trade. It could serve as the basis for a classroom activity.

Suppose Al has some marbles and Bob has a pocket knife. Al thinks he would like to have the knife, and Bob might like some marbles instead of the knife. Al is indifferent toward Bob, neither liking him nor disliking him. Al's reaction is a selfish one, since he is thinking primarily of himself. Similarly, Bob is indifferent to Al. Al would be willing to give as many as eight marbles for the knife, but would rather give fewer if Bob will accept them. Bob would be willing to give up the knife for as few as four marbles, but would like to get more if he could. We can diagram the situation as follows, letting the bars, which we will call Effective Preferences, or EPs, represent the limits of the terms of the transaction acceptable to each.



The EPs overlap between four and eight marbles, which means that the exchange might take place at any "price" between four and eight marbles given in exchange for the knife.

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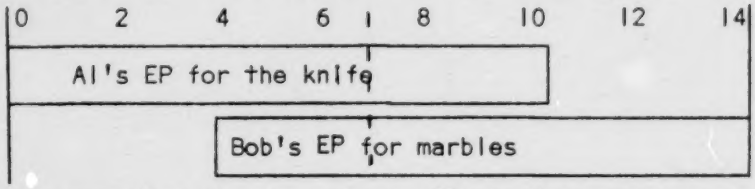
When bargaining starts, Al might first offer two marbles for the knife, while Bob might ask for ten. The transaction will not go through on either set of terms, since Bob will not accept the first and Al will not accept the second. After several offers and counter offers, if Al and Bob are equally good bargainers, the exchange will eventually take place at six marbles for the knife. A common way to bargain is for Al to pretend that he doesn't want the knife very much, and for Bob to pretend he doesn't care much for the marbles.

Let us now suppose instead that Al likes Bob and would like to please him, but that Bob is still indifferent to Al. In this case, Al's transaction will be motivated by generous feelings. Al might now be willing to give as many as ten marbles if necessary, while Bob is still not willing to accept fewer than four. The EPs in this case would appear as follows.



If we again assume that the two are equally good bargainers, and make equal concessions from their original positions, the exchange will take place at seven marbles. In contrast to the first situation, we can say that Al's generous feeling toward Bob has increased Bob's bargaining power and decreased Al's. A generous feeling is shown as an increase in the length of Al's EP.

Starting from the first situation, let us now suppose instead that Al dislikes Bob and does not want him to have what he wants. Their transaction will now be a hostile one. Al might then be willing to give Bob only six marbles at most. And if we still assume equally good bargainers starting from these EPs the exchange will take place with Al giving five marbles for the knife. As contrasted with the first situation, we can see that Al's EP has shortened as a result of his feeling of hostility. The result is that Al's bargaining power has improved while Bob's has been weakened.

If Al becomes so hostile that he is not willing to give more than two marbles, the situation will appear as follows. The EPs do not overlap at all, and therefore, the transaction cannot be completed. Al will keep his marbles and Bob will keep his knife.

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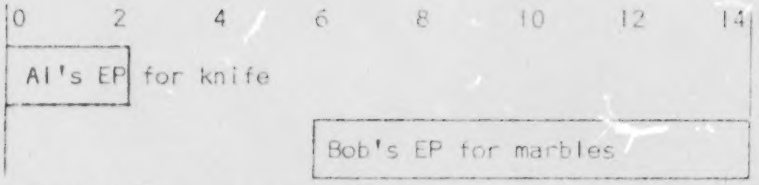
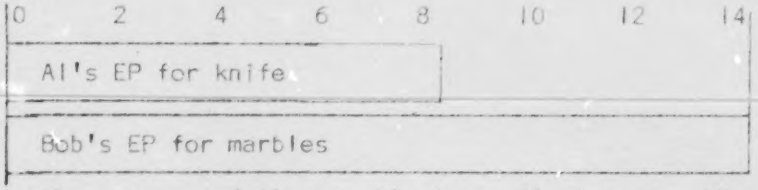


By contrast, let us now assume that Bob feels so generous toward Al that he is willing to give him the knife for nothing, even though Al is willing to give eight marbles, as in the first case. The EPs now appear as follows.



Depending on the outcome of the negotiations, Al might be able to get the knife as a gift. Or he might give as many as eight marbles for it.

Let us suppose that the situation is again like the first case. But Al now learns that Charlie has a knife just like Bob's and is willing to trade it for six marbles. As soon as Al learns of this opportunity, he is no longer willing to give Bob more than six. The existence of a "competitor" to Bob thus strengthens Al's bargaining power and weakens Bob's. We therefore say that Al's best alternative puts the floor under his bargaining power and the ceiling on Bob's. By the same reasoning, what would happen if Bob learned that he could get six marbles from Dave? Or eight?

If there were many "competitors," so that anyone with a knife to swap knew he could get as many as six marbles, and any one with marbles knew he could get a knife for no more than six, then we would have a "perfect market" in knives at a price of six marbles. Any economic market is simply the result of the interaction of many people willing to engage in transactions in the same pair of things (usually, money and another thing).

Transactions are sometimes made by using unwanted things instead of wanted ones. Bob might twist Al's arm, and say he won't let go until Al gives him some marbles. If the arm hurts only a little, Al may be willing to give only two marbles in return for being let go. But if the arm hurts a lot, he may be willing to give ten marbles to be released. If Bob feels neutral about Al, and doesn't want to hurt or help him, he has no desire to keep twisting the arm just for the satisfaction of it. He would then be willing to let Al go in return for no marbles if he thought Al would not

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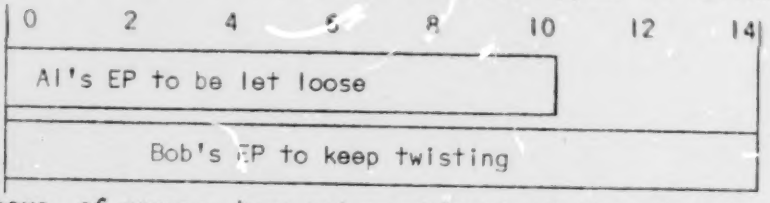
give in. If the arm hurt a lot, the EPs would appear as follows.



The boys, of course, have not negotiated whether Bob will start twisting Al's arm, which Bob does as a one-sided act. We call this act an application of stress. Stress is pressure applied by one side in order to increase its bargaining power over the other. A threat has the same kind of initial effect as a stress if the person being threatened believes that the other is able and willing to carry out the threat. Once Bob has applied the stress or threat, however, the two can negotiate over the terms on which the threat or stress will be removed. Under these conditions the transaction could be completed at any "price" between zero and ten marbles, depending on who is the better bargainer. One way for Al to bargain in this case would be to pretend his arm doesn't hurt. In fact, if Bob believed Al, he might give up twisting in return for little or nothing.

2.55 **Organizations.** Two or more individual systems, through communications and transactions, can constitute supersystems called **organizations.** An organization is designed to effectuate some goals as a unit; for instance, a business is designed to make a profit, a family's purpose is to raise children, and a political party is supposed to win power.

Any particular organization may be formed (1) for its own members, to produce things for themselves (a **cooperative** organization); (2) for its members to produce things for others with compensation (a **profit** organization); (3) for its members to produce or provide for others without compensation (a **service** organization); or (4) for its members to improve their bargaining power (a **pressure** organization).

Once an organization has been formed it can be viewed as a system in its own right, with its own detector, selector, and effector functions. The individuals within the organization take on specific **roles** within the organization, performing one or more of these functions. A role is a patterned set of behaviors through which one subsystem can interact in a fairly predictable and regular manner with other subsystems within a larger system. However, while fulfilling organizational roles, each person within an organization also remains a system of his own with his goals; and he

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may or may not share the goals of the organization. He may also occupy roles in other organizations which may have conflicting goals. These roles interact to create a complex network of human relationships.

All systems, including organizations, have a **structure.** The structure reflects the number and kinds of roles in the system and the kinds of interactions among them. For example, the officers and rules of procedure of an organization reflect, at least in part, the organization's structure. The structure is one important determinant of how well or badly the organization will be able to meet its goals. The knowledge, motives, and abilities of those who fill the organization's roles are other important determinants of the organization's ability to meet its goals. If the goals of an organization change, its structure and the qualifications of those who fill its roles may have to change in order to meet the new goals. Or if the structure and personnel of an organization change, its goals may have to be modified.

2.6 Change and Equilibrium in Systems

Organizations, which are supersystems of persons, can be combined with other organizations into super-supersystems. The development of higher level organizations is one form of social change. For example, after gaining their independence the original 13 colonies formed the federal system; or businesses often join together to form trade associations.

Organizations can also change merely by rearranging their parts, or by changing size, or number of parts, without developing higher levels of organization. For example, over the years the United States has added more states and some of these have changed their size, but no higher level of government has been added. A family may similarly add to the number of children without changing the number of system levels.

An important characteristic of any continuing system is a steady state, or **equilibrium,** in which interacting parts are in balance. Such an equilibrium permits predictability. For example, a business enterprise is in equilibrium if its production and sales are equal, or approximately so. If sales drop below production, production must be cut back to maintain equilibrium; if sales increase, production must be stepped up to maintain equilibrium. If sales are equal to the business's production at its capacity, then we may say that the business is in equilibrium at capacity. However, if sales increase above that level, the company's managers must decide whether to increase plant capacity in order to increase production and attain a new level of equilibrium.

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The business enterprise, like any other social system, has some built-in inertia which tends to preserve its equilibrium. This state of equilibrium is perpetually challenged by changes in science and technology, in value preferences, in climate, and by other forces. Some systems can make adjustments to change very rapidly; others cannot. If a system moves away from equilibrium indefinitely, it will eventually vanish or destroy itself.

The more open an organization is for trading ideas and goods (communications and transactions), the more exposed it will be to change, and the greater will be the potential variety within the system--for example, with respect to customs, food, taste, and language. In other words, the more open an organization is, the greater is the potential variety among the subsystems which compose it. By contrast, the more closed a system is, the more it will lose variety within itself or fail to develop new variety. However, no real system can be completely closed to effects from or upon its environment.

Certain changes are self-reinforcing. As such, they set in motion additional changes in the same direction, resulting in continued growth or decline of the system. For example, in an upward direction the more capital an economy accumulates the more efficiently it can produce; and the more efficiently it produces, the more capital it can accumulate. In a downward direction, the more science and technology a group accepts that challenge its traditional way of life, as with the Amish, the more the tradition breaks apart; and the more it breaks apart, the more science and technology it accepts. The phenomenon on which such self-reinforcing changes are based is called **positive feedback.** Feedback is information or action received by a system in consequence of the system's own prior action. Positive feedback is information or action that encourages further action in the same direction as the prior action. It is a self-reinforcing, self-aggravating, or "vicious circle" effect.

Other changes are counteracting, in that they set in motion opposite changes. Under these conditions a system neither grows nor shrinks but remains in or returns to equilibrium at or near its previous position. To illustrate this process, a river is self-cleansing up to a point. As more organic wastes are dumped into the river certain bacteria multiply because of the additional food supply, and as the bacteria multiply they destroy more wastes. Self-correcting or self-counteracting changes of this sort

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constitute negative feedback.

Any system may break down from **overload**, and not return to an equilibrium if some input is received faster than the system can handle it. For example, if too much sewage is dumped into the river the bacteria may be inadequate to handle it. If a political system receives a great overload of demands, the system may reach a point where it cannot handle them and break down.

Such are the main forces of change that make individuals, families, businesses, cities, regions, and nations develop, remain stable, or decline.

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3.0 A DIAGRAMMATIC REPRESENTATION OF SYSTEM CONCEPTS

The diagram on the next page displays the relationships among many of the concepts that have been described in Section 2.0 of this paper. It may help to fix the essential elements and structure of system analysis in the mind of the reader.

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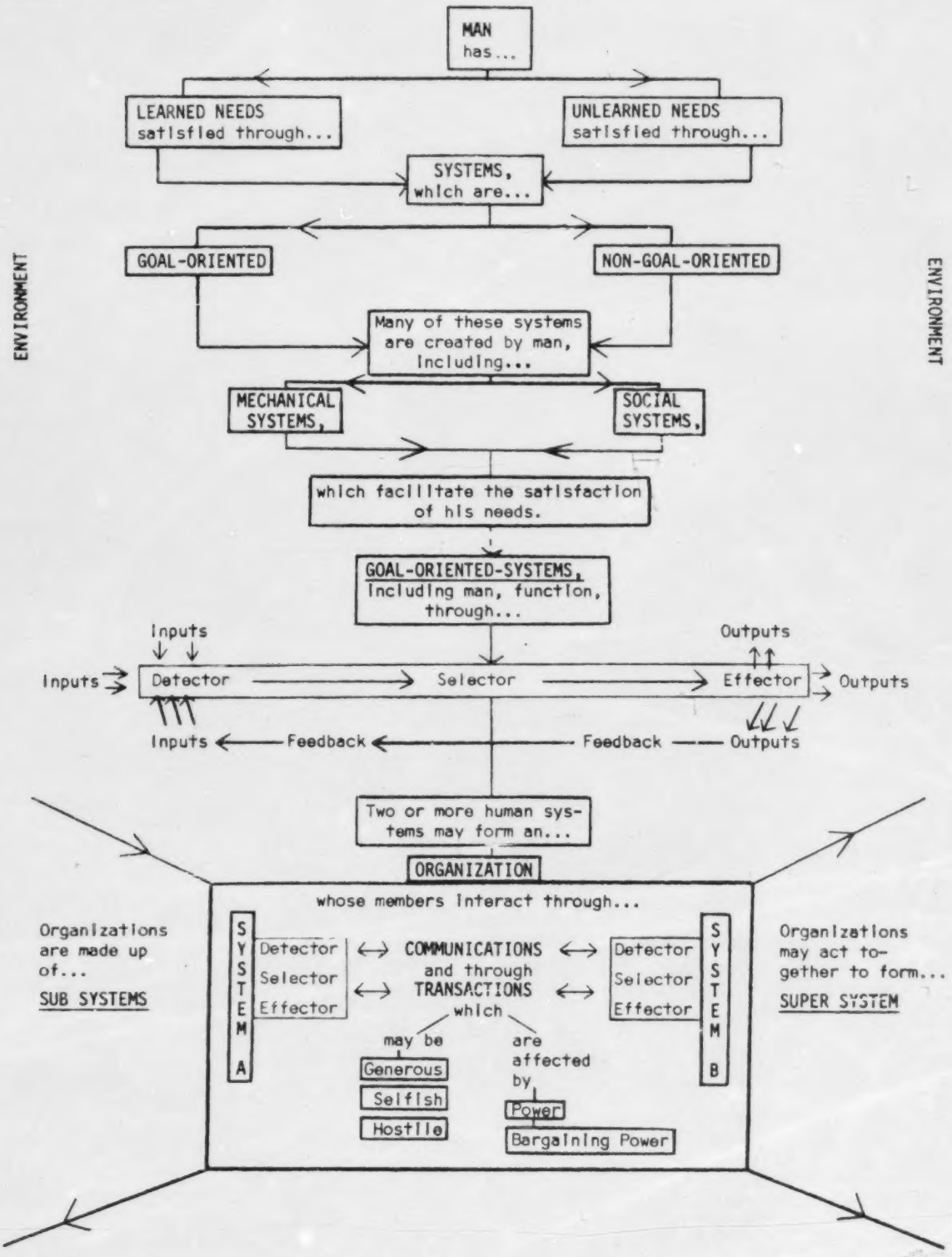

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4.0 THREE APPLICATIONS OF SYSTEM ANALYSIS

Now that the basic concepts on which system analysis is based have been examined, their applications can be shown through several different case studies, one focusing on system analysis of the family, one on analysis of ecological problems, and a third on analysis of poverty. By examining these problems, the nature of systems, as well as the interrelationships and interactions between intrasystem and intersystem analysis, can be more clearly understood.

4.1 The Family as a System

The family is an organization (a system made up of two or more human beings) which has particular goals. Some of these goals are universal among families. For example, families raise children; they also transfer beliefs, skills, and customs from one generation to the next. Because these functions are so necessary for the survival of society, many people consider the family fundamental and irreplaceable.

The particular ways in which families raise children and transfer beliefs have nevertheless changed over time and vary from place to place. For example, families have become smaller, moving from the extended family to the close, or nuclear, family. There are also fewer children per family now than in the past. Families have also delegated to outside institutions many tasks which were formerly its responsibility, such as education, recreation, and the production of many goods and services.

Each member of the family is himself a system with his own goals to achieve. Each member is therefore sensitive to his environment. He interprets information received from his environment and makes decisions to further his own goals. Each member of the family learns that he is a part of a bigger organization--that he is a subsystem of the whole family. As a part of the family, he interacts with the other members to achieve the goals of the family at large.

Family members interact with one another through communications. They also interact through transactions. These transactions may be generous, selfish, or hostile. In the family generous transactions are indispensable, especially in raising infants.

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While each communication and transaction can be studied as an isolated event, it is also important to realize that these single events may often have effects on subsequent communications and transactions. Since the relationship between members of the family is continuous, any communication and transaction within the family may have effects on subsequent communications and transactions among its members.

Each family has a structure through which it functions. This structure varies according to time and place. The family structure is made up of positions or roles which the individual family members fill. Roles filled by the various members of the family are important in dividing the work that must be done and in determining the hierarchy of positions within the family. Some members fill many roles inside the family. For example, a man is both husband to his wife and playmate and disciplinarian to his son. Some members fill many roles outside the family, such as employee, church member, and friend. Sometimes these roles conflict with one another.

Procedures also are a part of the family's structure. For instance, a family may have fairly regularized procedures for making rules and carrying them out; for producing goods and services, or earning a living; and for teaching its children, or helping them to shape their images about the world.

If the family changes or its goals change, its structure may no longer be appropriate. If this structure does not then change to meet the changing needs of the family, problems will result. Changes in families may be caused by internal forces, such as the changing maturity and ages of family members, the changing size of the family, changing roles, poor communications between members of the family, the changing mix of transactions (such as selfish transactions replacing generous ones), and conflicts among members of the family due to conflicting goals of individuals.

Changes in families may also be caused by external forces, such as income and employment changes, conflicts arising between the goals of the family and goals of institutions outside the family, conflicts arising between the roles members occupy outside and inside the family, changes in inputs coming from outside due to unexpected circumstances--such as fire, earthquake, and war--and changes in the composition of the family due to external forces--such as enlargement through marriage.

At any one moment the family may be in equilibrium. The longer the family stays in equilibrium, the greater is its predictability. Equilibrium

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is strengthened by inertia rooted in tradition. As a system, the family is continually exposed to outside forces that put pressure on it to change. The more closed a family is, the less it is exposed to change; the more open it is, is, the more exposed it is to change. Some of these forces may bring instability or disequilibrium; others strengthen the state of equilibrium.

Families interact with other families to form supersystems on various levels. Each supersystem may or may not have its own goals, depending on whether these are consciously built into its structure. A city, for example, is not in itself a goal-oriented supersystem, although it does create organizations which have goals, such as the city council and the public school system. A neighborhood is another supersystem which can organize to pursue goals, as by forming a welcoming committee or a volunteer fire department.

4.2 Ecology as a System

Unlike the family, which is a goal-oriented system, the universe is a non-goal-oriented system. Our solar system is a subsystem of the universe and the earth is a subsystem of the solar system. The surface of the earth is an ecological system in which many different parts interact. This ecological system has many subsystems, such as ponds, forests, and fields.

An ecological system is a particular kind of non-goal-oriented system, in which the interaction of components is uncontrolled. However, some of the components of an ecological system are themselves controlled systems, seeking their own goals, such as frogs, trees, birds, worms, and people. Other components are non-goal-oriented, such as water, air, and soil. An ecological system tends toward dynamic equilibrium, or a steady state. That is, its constantly changing and interacting parts tend toward balance.

Ecological systems and changes within them can occur with or without the involvement of man. Certain changes, such as floods, earthquakes, and the development of new species, may move the ecological system through successive stages to a new equilibrium. On the other hand, man, through his social systems, has changed the surface of the earth in many ways to serve his own goals, as in the draining of swamps, the clearing of forests for farming, and strip mining. Such actions change the ecological balance. Ecological systems thus created or modified by the interaction of man with nature can satisfy both man's social and biological needs.

In order to increase productivity, man develops increasingly specialized

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geographic areas, such as those devoted solely to mining, recreation, or dwellings. He is then compelled to move from one ecological subsystem to another in order to continue to satisfy his many needs. The resulting concentrations of activities may produce periodic overloads or underloads in particular areas.

At the beginning of man's history, the effects of his actions on nature were barely noticeable, because of the primitive state of his science and technology, his philosophical relationship with nature, and his relatively small numbers. As science and technology developed, as man changed his relationship to nature, and as populations increased, man's effects on ecological systems became greater. Man's efforts to promote his own interests may improve the natural environment, from man's point of view, and may thereby produce social benefits, as in the Tennessee Valley Authority and the drainage of swamps. However, man's efforts to promote his own interests may also harm the natural environment, and thereby produce social costs, as in air and water pollution, and in draining of swamps which may destroy the homes of many forms of wild life.

The costs and benefits of man-induced ecological change may fall upon different systems, individual or social, in the same or in different generations, and perhaps in different countries. As a result, it is difficult to estimate the amount of social costs and benefits. It is hard also to decide how these social costs and benefits should be distributed; their distribution can be influenced strongly by bargaining power within and among political systems. Sometimes a social cost cannot be traced to the person or organization that caused it; in such cases society at large or those directly affected must bear the cost.

The United States has experienced economic growth at the expense of the environment. During its early history, extensive use of the environment was probably economically wise, since the country had abundant natural resources, but labor and finished products were scarce. While using the natural environment "wastefully," the United States achieved the highest standard of living in the world. It now has the capacity to produce tremendous amounts of goods and services with the help of science and technology. But with today's growing population and an increasing amount of leisure time, the goals of the social system are changing. Perhaps from now on people may be more willing to forego the use of resources to produce goods and services in exchange for

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a more favorable environment. If we want to achieve this goal, science and technology may be enlisted to help man conserve many of the resources which he formerly took from nature to produce goods and services.

The use of science and technology has frequently injured the natural environment. But science and technology may also be used to produce new and better environments. If man does not keep the ecological equilibrium within bounds or conditions which meet the needs of individual and social systems, man himself may not survive.

4.3 Poverty

Everyone has some idea of what poverty is. Yet a clear, simple statement of what the word means is not easy. On the one hand, if a person has very little but is pleased and does not want more, is he poor? If another person has many things, but always wants much more, is he rich or poor? On the other hand, the level of income that makes a person poor varies from time to time and from culture to culture. A person may think of himself as poor even though he has much more than his grandfather, who may have been considered rich. The unskilled immigrant who earns $2.50 an hour in New York may also be considered very poor, even though he is far better off than his brother who remains a farm worker in Puerto Rico. Whether one is considered poor is thus in part relative to other times and places--a matter of how a person is perceived by himself and by others.

We can nevertheless say that in general a person, or his family, can be considered poor if he has very few goods for satisfying his wants. Since power is the ability to get wanted things, being poor is the same as having very little of one kind of power. Hence the way to remedy poverty is to see that the poor get more of that kind of power.

4.31 Intrasystem aspects of poverty. A person or family may live almost alone, like Daniel Boone or a peasant in a remote area. Such a system must satisfy its wants by producing through its own efforts. Or such a system--a person or a family--may produce things through its own efforts and then exchange them for other things to satisfy its wants. In either case, if it cannot produce much it will have little power, and be poor.

An individual's power to produce may be weak because of inadequate knowledge of what to produce or how to produce it--an inadequacy of his detector. For example, he may not know that corn would grow much better than

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wheat in his soil. Power may also be limited because of weak motivation--an aspect of the selector. For example, Daniel Boone might prefer to sleep in the sun instead of setting traps for animals. Power may also be weak because of poor ability to do or to make things--a fault of the effector. For example, a person may not be strong enough to cultivate the hard soil, or skilled enough to do good carpentry.

A person--or any other kind of system--must use resources from his environment if he wants to produce things. Even if he has great knowledge, motivation, and skills, he still may not be able to produce very much--and thus be poor--if the resources in the environment are scarce or of poor quality, as in the desert or in the Antarctic wastes.

Thus a person's power can be increased, and he can be helped out of his poverty, if his knowledge (detector), his motivation (selector), or his skills (effector) are strengthened. He can also be helped by having better environmental resources made available to him.

4.32 Direct intersystem relations. Most people get many things they want through interactions with others. If intersystem power is low, poverty may be the result. One of the causes of low intersystem power may be poor communications. If a person is illiterate, he will be unable to learn by reading books or newspapers. He will also be unable to write to employers about possible jobs and to fill out application blanks. If he cannot speak well he may not be able to make his wants known clearly to others. Many higher paying jobs require the ability to read, write, and talk well. If a person lacks these communication skills, he cannot hold such jobs. In addition, people are often judged by their speech. If they use bad grammar or have an accent that others associate with lack of education, those who hear them will tend to think they are ignorant, even if they are not. And if the poor associate and deal mostly with others like themselves, the communications they receive may not provide them with the kind of information they need to improve their power.

Lack of power and of bargaining power in transactions are the main reasons why some people remain poor. A system has great power and bargaining power when others strongly want what it can provide; that is, the others have long EPs (see Section 2.54). In a money society this means that others would be willing to pay a relatively high price for what a system has to offer. Most people receive an income by selling their services or their labor. If

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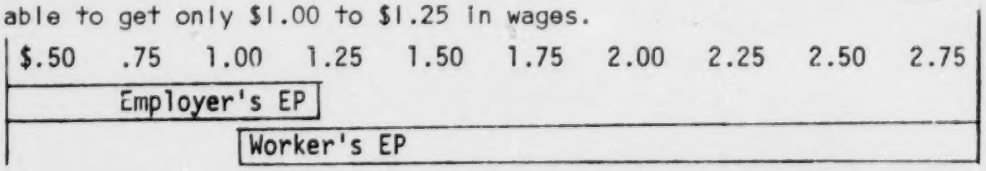
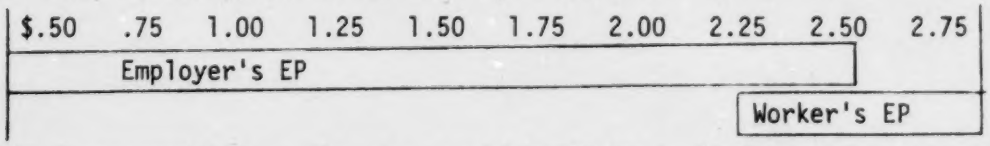
a person has only low levels of skill or talent, his labor will not command a high price. To rise above poverty he may then try to improve his skills. A person may also be poor if he has a high level of skill but lives in a region where nobody wants to use that skill or its products. For example, he may be an excellent bricklayer, but live in an area where all buildings are made of wood. He may rise above poverty if he moves to a region where his skill is needed. To do this he must be willing to leave the friends and surroundings with which he is familiar. He must also be able to pay the costs of moving.

In our society a poor person needs money very much. He may therefore be willing to go far out of his way to find someone who will give him a job. But if he has few skills and many others want the job, the employer need not go out of his way to hire him. Such a person then has very little bargaining power to get a job or good wages. He has a large EP for the money the employer can give him, but the employer has a small EP for his work. Thus his bargaining power is very low. In the diagram below, we can see that he will be able to get only $1.00 to $1.25 in wages.



On the other hand, if the employer needs him more, and he himself does not need money so badly, the situation might look more like this.



Under these conditions, the wage would be $2.25 to $2.50 an hour, because of the worker's greater bargaining power.

If whites do not like blacks, a black may have to go far out of his way to find a white who will give him a job or sell him a house. Because his bargaining power in trying to get the job or the house is very low, he will remain poor. If the employer is required by law to hire more blacks, and if those with particular skills are scarce, the bargaining power of the blacks then rises.

Anyone who is a poor negotiator, because of either poor tactics or poor strategy, will lose out when he buys or sells. Hence improved ability to negotiate will also help a person to rise above poverty.

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The poor may sometimes be helped by generous transactions from others. The generosity of friends and neighbors may sometimes help in an emergency, but it cannot help much to remedy the overall problem of poverty. Generally, the friends and neighbors of the poor are also poor. The rich, who might help more, often have other rich persons for friends and neighbors, and they do not need help. For these reasons, generous help from those with more income to those with less income is mostly channeled through some kind of organization, such as the Salvation Army or the government.

Organization or coalition is another way to increase power. Poor people can sometimes improve their bargaining power by joining together to bargain collectively. The formation of a labor union to bargain for higher wages and a tenants' union for lower rents are examples of such organizations. People may also join together to form an organization so that they can produce more efficiently, as in certain kinds of farm cooperatives where people help one another. In a tenement building people might join together to help remove trash or rats. Or they might form a business firm to produce and sell their services more effectively, such as an appliance repair service, a service station, or a housecleaning service. Small manufacturing firms might start this way and then grow.

4.33 Intersystem relations in the broader society. In addition to direct person-to-person relations, interactions among broad groups of people also occur. These may or may not involve the government.

If the government is to help the poor it must first learn something about them: who they are, how many there are, how poor they are, and where they live. This can be done by surveys and research. If citizens with more income are to help the poor, they must also know of them. One sort of silent communication is for those who have more income to see the slums. The rich often avoid this reminder by living where they can ride to work without seeing any slums. The poor act deliberately to communicate their plight to the government or to those who are better off than they by such actions as the Poverty March on Washington or picketing the city hall. An important message to be communicated by those who understand the problem is that the elimination of poverty is possible. The government and others will not have a strong desire to do anything to eliminate poverty unless they believe it is possible to do so. In the latter case goals in the selector are modified by new information in the detector. Dramatizing the plight of the poor is another

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way of communicating information to people in an effort to change their goals.

One way the government can help the poor is to meet their needs directly by supplying food, clothing, and housing, or the money to buy them. Such help is useful only while it continues. Another method of helping the poor is to increase their power more permanently by training them for better jobs, by helping them to move to areas where better jobs are available, or by teaching them how to take better care of themselves. Such help may be useful long after it is given. In a direct sense these actions are all generous transactions on the part of the government. However, the government might later get back what it gave if the people it helped could earn more and then pay more back to the government in the form of taxes.

Persons with higher incomes may similarly help the poor through private service organizations, such as charities. These people may have various motives, such as true generosity, a sense of guilt, or a belief that the waste of human resources hurts society. For similar reasons they may vote to authorize the government to help the poor. The greater the desire (the longer the EPs) of others to help the poor, either directly or through government, the greater will be the power and bargaining power of the poor.

An election is a kind of transaction as well as a communication of the voter's preference. This transaction says, at least implicitly, "I will vote for you if you promise to do what I want after you are elected." In this transaction the poor usually have more votes than the rich because there are more of them. However, the poor do not necessarily win at the polls, since those who are elected often do not represent the interests of the poor. The rich, on the other hand, do have bargaining power with elected officials, since they make contributions to their election campaigns. The rich may also own newspapers which may support their candidates. Blacks in the South long had little or no political power because various devices were used to keep them from voting.

Bargaining power in politics can also be increased by collective action. If the poor can form a solid voting bloc (coalition) they gain more bargaining power with the candidate, since he then has a longer EP for their vote. To bring about the desired result, the poor must communicate to the candidate that they are a bloc and that they have particular wants.

By using organizations the poor sometimes pool their efforts to change the direction of the larger society. They may form lobbies to communicate

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with the Congress, gather information and publicize it, or jointly hire legal assistance to prosecute their cases through the courts.

If they feel desperate, the poor may try to improve their bargaining power by threats, such as creating disturbances or boycotting businesses. Such threats may sometimes work. However, the serious disadvantage with a threat is that if it fails to work, the party who made it may feel he must carry it out whether he wants to or not, or his future threats will not be believed. Threats may also backfire and worsen bargaining power if they generate hostility and thereby shorten the EP of the other party.

4.34 Does poverty have a future? There is a strong tendency for the difference between low and high power to increase. The more power one already has, the easier it is to get still more. The less power one already has, the harder it is to increase it, and the easier it is to lose what little one already has. For example, if a rich person is arrested for some reason, he can almost always get the bail necessary for prompt release until his trial. But the poor man often cannot get enough bail. Hence he may lose wages while waiting in jail for his trial and he may also lose his job, even if he is eventually acquitted. In addition, the person with more money to start with can get better training, wait longer, or travel farther to find the best job. Therefore his earnings will tend to go up faster than those of a poor man who cannot do these things.

Unless other stabilizing forces are introduced, the difference between the rich and the poor may thus tend to become greater and greater. Progressive income taxes and governmental assistance to the poor are two measures taken to keep the overall system from getting farther and farther from an equilibrium and to bring it closer to equality.

Within a society power based on threats is very temporary and unstable. It invites retaliation because it takes power away from others. On the other hand, power based on increased ability to produce through better information, motivation, or skill is permanent and stable. It helps the person who has the power. It also helps others by making more or better goods or services available to them.

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5.0 CLASSROOM ACTIVITIES

The activities described below are grouped for easy reference according to topics presented in Section 2.0 of this paper, following the general pattern of the diagram in Section 3.0. Many of the activities are overlapping and can be used to illustrate more than one concept. The final group of activities helps to relate system concepts directly to students' daily lives, giving the types of situations most frequently encountered and therefore of most direct relevance to them. Thus these activities can serve as a final wrap-up to a study of system analysis. These suggested activities are not intended to be exhaustive; they should facilitate the teaching of system analysis and be a help to the teacher in developing other classroom activities.

5.1 Systems--General

5.11 Identifying systems. To get the class started on identifying familiar systems, use the example of the U.S. space program. Ask the children, "What is the announcement that the space center makes just before the launching of a rocket?" or "What conditions are necessary for a successful launching?" One likely answer is, "All systems go." Following this, ask the children to suggest what some of these systems are and list them on the chalkboard. For instance, they may suggest the spaceship itself as a system, the team of astronauts as a system, the propulsion system, the guidance system, the communications system, the weather system, the U.S. Navy, the U.S. Air Force, each separate manufacturer of components for the spaceship and other systems, each individual astronaut, and so forth.

This discussion may then be broadened by asking the class to name some combinations of things that are commonly referred to as systems. List on the chalkboard what the students suggest. Answers might include the following: telephone system, sewage system, transportation system, park system, court system, housing system.

5.12 Understanding that a system is the interaction of two or more parts. Ask the class to identify what objects in the classroom have parts which work together to "get something done." Write answers to this question on a chalkboard. These might include the following: a pencil sharpener, a pair of scissors, a light bulb, a door lock.

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After discussing various classroom objects, suggest considering the class itself as a system. What are its parts?

What about a person? Answers might include the following: the brain has ideas and the heart, liver, arms, and legs work together to fulfill these ideas.

5.13 Understanding that some systems are made up of many interacting subsystems. Ask the students to make drawings on small sheets of cardboard depicting several systems found in a city, such as the transportation system, the school system, the housing system, and the recreation system. From these drawings construct a mobile showing the various systems within a city. In trying to achieve a balanced mobile, using pictures of subsystems of various sizes, discuss how city planners try to balance the city's subsystems to achieve the goal of keeping the citizens happy. Note that if one element in in the mobile is changed, then other parts must be adjusted to maintain a balance.

It might also be brought out that man is constantly creating systems to help deal with his problems. Man sometimes consciously establishes a goal and then designs a new system or modifies an existing one to achieve it.

Going beyond a discussion of the city, the class can consider how a country is made up of many subsystems; then go on to consider the world. All these subsystems interact in a world which is one great system with everything else a subsystem, or a subsystem of a subsystem.

5.14 Understanding the differences among systems. Have the students begin by naming the systems which surround them. List these on the chalkboard as they are identified. Systems should be grouped into three categories: those made up of people, those created by nature, and those which are mechanical or man-made. Some of the systems which might be listed are: typewriter, school, pond, drugstore, watch, human body, teacher, PTA, employment bureau.

The common characteristics of each category should be pointed out. For example, all are made up of parts which interact.

Further discussion should bring out that in some systems made up of humans, everyone works together to accomplish some goal or purpose. In other systems, such as those found in nature--a pond, for example--the plants, animals, water, and minerals interact, but each living part or member of the system pursues its own goals without formulating a goal for the system as a whole.

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5.2 Goal- and Non-goal-oriented Systems

5.21 **Understanding the similarities and differences between a goal-oriented and a non-goal-oriented system.** Divide the class into two committees. If possible, one should visit a farm (a man-made, goal-oriented system); the other should visit an underdeveloped part of a state park (a natural, non-goal-oriented system). After these two trips, or watching films depicting these systems, the class should discuss the following:

1) Is a farm a system?

2) Is the wilderness a system?

3) What is the regulating force in both systems?

4) What are the differences between the two systems?

It should be pointed out that a farm is a nature-made system modified by man in order to achieve a goal--to increase productivity. Man reduced a diversified natural system to a more specialized man-made one, a farm. The wilderness is a nature-made system which achieves balance through the interactions of diverse parts. It has no goal of its own although each part has its individual goals.

5.22 **Understanding the importance of man-made systems in daily life.** Ask students to name several man-made systems which help to achieve each of the following goals:

1) keeping their homes warm in winter and cool in summer

2) transporting them around their city and to other cities

3) providing recreation in their homes and neighborhoods and in distant places

4) preparing different kinds of food to make them more edible

5) assisting people in communicating with friends and relatives

6) helping to keep people's homes clean and neat

Ask the students if any of these systems have "goals" built into them (such as thermostatically controlled heating and cooling systems). Which are non-goal-oriented? What happens to them when man uses them?

5.23 **Understanding that there are many ways of distinguishing among systems.** Divide students into three committees. Committee 1 should find examples of systems in the home or within the family, such as father, mother, children, family, heating system with thermostat, electric refrigerator, sewing machine, and plumbing. Committee 2 should list systems located in the city, such as the water system, sewage system, fire protection system,

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political or governmental system, and a business--one store identified as part of an economic system, for example. Committee 3 should list systems on the national level, such as the federal government, the highway system, defense system, court system, banking system, social security system, river system, and the national park system.

Each committee should describe the many parts that make up these systems, and how these parts work together. The students should also explain who created the systems, pointing out that some have been created by man while others have been created by nature. Still others are a mixture of man-made and natural. Students should go on to identify different kinds of man-made systems: some are mechanical; others are social. Social systems have been created to help people work together to make a living, or to better their relationships with other people, such as helping them achieve greater security, independence, and happiness. Man has also modified natural systems; for example, by draining swamps or stocking streams with fish.

The committees should point out that the job of most of these systems, whether man-made or man-modified, is to ensure that the parts will work together to accomplish some goal or task. It should be emphasized that sometimes the working together of the parts of a system or subsystem is not a smooth process. For example, the different subsystems which make up the larger city system, such as the highway department, the parks department, and the zoning board, often do not work together for a common goal. Furthermore, they may not even agree on a common goal. Similar difficulties may arise in a family where some members may want to "go their own way."

Students should discover that some systems are not goal directed. For example, a river system does not guarantee a water supply for man or a constant water level. It should also be pointed out that a system such as a sewing machine or the plumbing system in a house is designed by man to meet his goals. However, there are no goals built into these systems themselves, such as there are in other man-made systems like a thermostatically controlled heating or refrigeration system.

5.3 Goal-Oriented Systems

5.31 Discovering that some systems have goals. Students should complete the following sentences:

1) A purpose of the family is

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2) A purpose of a business is

3) A purpose of the Salvation Army is

4) A purpose of a school is

5.32 Identifying systems that accomplish goals. Ask students to name the following systems:

1) I am thinking of a system where people can borrow money.

2) I am thinking of a system where people go to pray.

3) I am thinking of a system where people go to study.

4) I am thinking of a system that brings letters from my friends.

After identifying these systems, students should identify the goal or goals of each. They might also ask if the people who operate the system have the same goals as those who use its services.

5.33 Discovering that the various parts of a system must work together to fulfill a goal. Have students act out a sociodrama in which they play different roles in a family. The sociodrama illustrates how each member, through doing his chores, helps to achieve the goals of the family in raising children and teaching them to become grown-up men and women. The sociodrama may also show that, while the members of the family are working together for its benefit, each one has other commitments to himself and other people which may or may not conflict with the purposes of the family. These commitments might include the following: a son or daughter taking a parttime job, the mother taking a job which keeps her away from home during the day, or outings which are planned by an individual family member without consulting the others.

5.34 Understanding that man invents systems to satisfy his needs. The class can discuss the following questions:

1) What system(s) did man invent to raise children?

2) What system(s) did man invent to produce cloth?

3) What system(s) did man invent to sew clothing?

4) What system(s) did man invent to resolve conflicts between people and nations peaceably?

5) What system(s) did man invent to produce goods in large amounts by means of an assembly line?

6) What system(s) did man invent to educate himself?

7) What system(s) did man invent to enjoy nature during his vacation?

After identifying the system or systems in each case, students can then

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discuss the system components. They may discover that some systems have many subsystems. For example, in order to resolve conflict peaceably, lawmaking systems, law-enforcing systems, and systems that interprets laws have been developed.

5.4 Intrasystem Analysis: Detector, Selector, Effector

5.41 Discovering how a system functions to fulfill certain needs. Have the class pick a goal-oriented system to talk about in detail. Raise the following questions about it:

1) What must the system "know" if it wants to reach its goals effectively?

2) What choices or alternatives does it have as possible ways of meeting these needs (reaching its goals)?

3) How does it choose among alternatives in order to meet its needs?

The discussion should bring out these points:

First, the system must be aware of the state of its environment. For example, someone in the water system must have information about water resources, the number of families who need water, the consumption of water per family, and the total consumption of all families and businesses in the community. In addition, if the system is an organization, it must also be aware of its own structure and what each part of the structure does; that is, the various parts or roles in the system and how they are related to one another.

Second, the system must know how to meet its needs in a variety of ways. For example, the water system may use either ground or river water. The people who organize the water system may decide to finance it from general taxes or to assess each family. The school system may satisfy community needs by building one big school for all the children in the city or by building a number of small neighborhood schools.

Third, the system, or the people in it, must decide between alternatives. For example, the water board may decide to use ground rather than river water. Or the school board may decide to decentralize the school system.

If the students seem ready, the points which have been discussed should be identified with the following steps:

1) The people acting in the system must know about the state of the environment (detector function).

2) They must select from the various choices the one best suited to

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fulfill the needs of the system (selector function).

3) The people in the system must translate the alternative selected into action (effector function).

5.42 Understanding the functions of detector (knowing), selector (wanting), and effector (doing) in a goal-oriented system. Choose a very hungry student to help with the following demonstration. Three different kinds of fruit are placed on a table and the student is asked to describe what he sees. Explain to the class how the student sees with his eyes (the detector function); that is, he perceives a certain state of his environment. Then point out that student may choose one of the three; that is, he now perceives his choices (still part of the detector function). The student then chooses one of the pieces of fruit (the selector function). When the student picks up the fruit and eats it, he is performing the effector function.

5.43 Demonstrating that knowing, wanting, and doing are ongoing processes. The above exercise may be repeated, assuming that the student who participated in the demonstration before is still hungry. Then the student will discover that two pieces of fruit are still left on the table (detector); he may choose one of them (selector), and eat it (effector). Or he may choose not to eat any more if he is no longer hungry.

Students should discuss the following question: "After you have eaten a sandwich to satisfy your hunger, will your body as a system be satisfied?" One student may say that his body will tell him that he is still hungry. In other words, his selector mechanism is saying that more food would be pleasant. Another student may say that his body will tell him that he has already had too much and that he may need to take an Alka-Seltzer. That is, his selector is telling him to stop eating since more food would be unpleasant.

5.44 Understanding how the detector, selector, and effector functions of man are learned. Students can report their observations of these functions in younger brothers and sisters. One may tell how a baby brother or sister communicates the need for food: how crying and/or laughing slowly become words; how words, as the child grows older, become speech; and finally how speech, with time, becomes a more and more accurate expression of ideas.

Another student may report how a brother or sister learned to focus his eyes and was able to observe with increasing accuracy the objects around him. He may observe how all the other senses are increasingly able to take

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in the environment and how slowly the child learns to express likes and dislikes and other feelings about his surroundings.

It should be emphasized that the five senses together enable man to detect. The better these senses are trained through education and learning, the more successfully people are able to live in their environment.

5.45 Understanding that man fulfills his needs by acting as a system. Ask students to name several of man's needs and write them on the chalkboard. The list should include physical needs, such as hunger and thirst, and emotional and intellectual needs, such as companionship and curiosity. Ask the students to explain how each of these needs is usually met. What does man do when he is hungry? What does man do when he is lonely? Then ask the students to identify and describe how each of the three processes or functions of the human body (detector, selector, and effector) plays a part in satisfying each of these needs. Class discussion should bring out that man recognizes his various needs through his senses and his brain (detector), that the appropriate parts of the brain respond to pain or pleasure (selector), and that various bodily systems, such as the muscular system, help man to fulfill his needs (effector).

5.5 Detector

5.51 Discovering that everyone has mental images about the outside world and that these images may differ. Students should close their eyes and describe different objects: a tree, a mountain, a school, a farm, a store, a lake. The class will discover that without looking at an object, a person can still describe it because he has formed an image of it in his mind from his previous experience. Some of the descriptions of objects differ from each other because of incorrect knowledge or differences in knowledge or experience.

To go one step farther, the class might watch a film depicting an episode in American history. Students should then write a short essay describing what they saw. Similarities and differences may be discovered in their reporting as a result of the different images generated by the film in their minds. Students should discuss what the reasons for these differences could be.

To approach the concept of image from a different point of view, have students write essays on the topic, "What should we do with the unemployed?"

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Students should then compare what they have written to discover differences in their approaches. The class might be assigned another essay, "Who is a poor person?" Again, students will discover that they have different images about the characteristics of poor people. The different images students have about the poor (the detector function) may be a clue to the differences in technique they would approve to eliminate poverty (the selector function).

5.52 Understanding that the image a person has depends on what he sees (detection) and that different people see things differently. Show the class several examples of optical illusions. For example, a pencil in a glass of water appears broken where it touches the water's surface. Several students should explain to the class what they see and how what they see changes.

To extend the idea that different people have different images, ask several students to write a short description of some object and then compare the results. For example, in describing a broom, one student may write about a push broom, another a whisk broom, and another a straw or plastic broom.

5.53 Understanding that hearing, as well as seeing, may give a person incorrect information. One student should whisper a sentence to someone in one corner of the room and ask him to whisper it to his neighbor, and so on, until the message has gone around the room. Ask the last person to write down the message he got, and then compare it with the original message. The message usually changes considerably, which would indicate not only faulty receiving (detecting), but also faulty sending (effecting).

5.54 Discovering how important accurate information is in forming an image. Students should read the following statements and discuss whether the statement is sufficient to create a correct image in the mind of another person.

1) Worker wanted--job is just right for you!
2) Giant hamburger--5¢
3) Young man wanted--no college necessary--can earn $500 per week
4) Car for sale--$300
5) John likes electric trains.

5.55 Discovering what happens if the detector is defective. Have students act out what can happen to a person if he is blind, or deaf, or cannot read. They might also act out the kinds of problems that may arise if a person makes foolish decisions, or what might happen if a person is drunk or under the influence of drugs that could impair his detector, selector, or effector

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functions.

To reinforce the above activity, tell the class the story of Helen Keller in order to show the agony she went through as a child because of her inability to see, hear, or speak. Students might also invite a blind person to tell them how their handicaps affect their daily life.

5.56 Discovering how a mental image may blur the actual facts. Have some students act out short episodes such as the following: one student rushes into the room followed by a policemen, and then rushes out again.

After this episode, have other students write a story entitled "Policeman Chases Man." The story should describe the action which took place, the cause of the action, and the two characters. The students should then compare their stories. They will differ depending on each student's image of the policeman and his role in maintaining order.

5.57 Discovering that images change with a person's maturity. Have the class play a change-my-mind game:

1) Student A pretends that he once thought water was manufactured behind the faucet; now he has changed his mind. He should describe the more realistic image he now has and explain why his image changed.

2) Student B pretends that he once thought babies were brought by the stork; now he has changed his mind. He should describe the more realistic image he now has and explain why his image changed.

3) Student C pretends that she once thought glass was air because you can see through it; now she has changed her mind. She should describe the more realistic image she now has and explain why her image changed.

4) Student D pretends that he once thought all people who did not work were lazy; now he has changed his mind. He should describe the more realistic image he now has and explain why his image changed.

5) Student E pretends that she once thought people who didn't work shouldn't eat; now she has changed her mind. She should describe the more realistic image she now has and explain why her image changed.

6) Student F pretends that he once thought people with skin color different from his own were smarter or not so smart as he; now he has changed his mind. He should describe the more realistic image he now has and explain why his image changed.

7) Student G pretends that she once thought laws were made by the President of the United States; now she has changed her mind. She should describe

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the more realistic image she now has and explain why her image changed.

8) Student H pretends that she once thought her father was "making money"; now she has changed her mind, since she knows that her father is the producer of goods or services for which he is earning an income. She should describe the more realistic image she now has and explain why her image has changed.

5.6 Selector

5.61 Understanding the importance of selecting from among many possible goals. Ask the class:

1) Why can't every family have everything it wants? It should be pointed out that most families always have more wants than they have resources to pay for goods and services.

2) Why can't both parents work all day and let their children raise themselves? Discussion should show that without outside help, one parent usually must stay with the children while the other earns the family income and assures its safety.

3) Why is it difficult for most people to enjoy city life and country life at the same time? Answers should include the fact that because people choose to live close to jobs, schools, and shops, there are many people per square mile in cities and therefore they are farther from the country.

4) Why can't a person follow the customs of his family obediently and at the same time adopt new ideas?

5) Why can't we help farmers by promising them more income and encouraging them to produce more?

6) Why can't a lawyer represent both the accused and the victim? Why can't a lawyer represent both union members and management? The discussion should help the class to discover that when a person or a system makes a decision, this decision to achieve a certain goal may be in conflict with other persons or systems.

5.7 Interaction of Detector-Selector-Effector

5.71 Discovering that the interactions between detector, selector, and effector are the means through which the system achieves its goals. Put the following columns on the chalkboard and fill in appropriate parts of the three columns as students provide information during a class discussion.

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	Detector (knowing)	Selector (wanting)	Effector (doing)
Example	Johny knows that to have money he may need to steal, get a loan, or look for a job.	Johny wants money and prefers a job as the best way to get it.	Johny checks ads in the paper and is soon at work.
	Johny discovers that his boss is not satisfied with his work.	etc.	etc.
	Eric knows that to satisfy hunger he can buy candy, peanuts, or a sandwich.		
	Sarah finds she has free time.		
	Sarah gets soaking wet walking in the mountains		
	The government decides to do something about the poor housing poor people live in.		
	Jimmy knows that to get a good job, he must have a good education.		
	Dick realizes that Larry wants to fight him.		

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After the class understands the relationship between detector, selector, and effector, point out the crucial importance of developing the right image about the state of the environment (detector function). An incorrect image could cause problems for the system. For example, Eric could have decided to satisfy his hunger by eating candy all the time. Such a decision might lead to sickness. Or the government could decide not to do anything about poor housing since "poor families get what they deserve." Such a decision might lead to neighborhood riots.

5.72 **Discovering that many environmental problems are caused by people's failure to consider all possible courses of action and/or the consequences of these actions.** Have two students act out the following scene:

1) Father must go to the office every day. He thinks about his choices (detector):

a) I could take the stationwagon.

b) I could take the small car.

c) I could share my neighbor's car.

2) He prefers his small car because it is easier to park (selector).

3) He drives the small car to the office (effector).

The son after listening to his father's deliberations, tells him that he did not give enough thought to his choices.

The class should discuss whether the son was correct, and if so, why. It should be pointed out that, in the detector stage, the father did not consider walking, bicycling, or using public transport. In the effector stage he did not consider the consequences of his choice in terms of his contribution to the traffic problem, air and noise pollution, and even the possible destruction of the environment by mining and lumber companies which contribute to car manufacturing.

5.73 **Understanding how the detector, selector, and effector work together.** Divide students into various committees. Have each committee choose one of the following: telephone system, sewage system, transportation system, court system, or some other system. Each committee should then prepare a history of the system and draw a network diagram or map of the system. They might prepare charts or posters with cutouts from magazines showing different components of the system and how they are related to each other. For example, a water system may include a river or water course, purification plant, pipelines, many houses and businesses, water meters, and water outlets. The school

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system drawing may include buildings scattered throughout the city, the school board in session, the superintendent's office, teachers in a building, and students behind desks.

Have each committee report to the class on the drawing of the system and give its history. Class discussion should bring out that:

1) Each system is made up of many parts working together (the structure of the system).

2) These parts work together to accomplish one or more tasks (the effector function of the system).

3) The system fulfills a need or needs (determined by the selector of the system itself or of the system which created it).

4) To see if the system is still fulfilling those needs, information is collected from time to time (by the detector of the system itself or of the system that controls it).

Ask each committee, "What would happen if the detector(s) in your system failed to work properly? the selector(s)? the effector(s)?"

5.8 Intersystem Analysis: Transactions

5.81 Understanding the meaning of a transaction. Hand out two lunch boxes to two members of the class. One student, preferably with the smaller appetite, receives a lunch box containing four very appetizing meat sandwiches. The other, with a much bigger appetite, receives a lunch box containing six Girl Scout cookies. After the students open the lunch boxes, each must report to the teacher (in secret) how much value he attaches to the food the other one has. In other words, how much he is willing to give up of his food to get some of the food which belongs to the other. To get the best bargain in trade, the students are advised not to disclose the significance they attach to the food the other one has. They may pretend complete indifference to the sandwiches or the cookies. They may even try to devalue the quality of the other's food. For example, one student may state that he is not interested in the meat sandwich, since it is not turkey as advertised, but horse meat instead. After the bargain has been completed, the students should discuss the following questions:

1) How many sandwiches with respect to cookies have been gained by playing tactics and strategy?

2) Would you have changed your tactics and strategy if the other person

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in the trade had been a good friend or someone who was starving?

3) Would you have changed your tactics and strategy if the person you were trading with was someone you didn't like or someone who had harmed you?

The discussion should bring out that the students performed a transaction--the transfer of something on which they placed a particular value.

5.82 **Understanding the ways transactions work.** For bringing out the nature of transactions in more detail, the teacher should have the students role-play the several transaction situations described in the section of the paper on transactions, pages 14 through 17. Use the chalkboard to show the scales representing the various Effective Preferences. In discussion, bring out the conclusions mentioned following each episode in the series of transactions.

5.83 **Discovering various types of transactions in a family.** Students should act out a sociodrama demonstrating these transactions:

1) a mother feeding her baby (generous transaction)

2) a young boy helping his ailing grandmother (generous transaction)

3) two brothers bargaining with each other: "I'll let you use my bicycle if you'll give me your baseball bat." (selfish transaction)

4) a father telling his child, "If you aren't home by 5 o'clock for dinner, you can't go to the baseball game tonight." (threat transaction)

After the sociodrama, the class should discuss the great importance of generous transactions in a family. They may come to the conclusion that if everyone acted selfishly in a family, the system could not survive.

5.84 **Discovering that there are many transactions in society that are carried out under threat but with social consent, although such social consent has a limit.** The class should discuss the following transactions:

1) Threat transactions with social consent:

a) Do not throw trash on the highway--$50 fine.

b) Parents will be punished if their children don't go to school.

2) Threat transactions which do not have social consent:

a) If you pay me $50,000, your kidnapped husband will be freed.

b) If you shoot another person intentionally, you yourself will be shot.

5.85 **Discovering that there are certain threat transactions which have social consent but not unanimous approval.** Students should discuss such questions as:

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1) Is the death penalty practiced in all fifty states?

2) Are there any states in which the death penalty not allowed?

3) What could be the reasons that in some states social consent exists and in others it does not?

4) Do you think that in states where the death penalty is legal, everyone agrees with it?

5) Can people who do or do not agree with the death penalty do anything about their preferences?

5.86 Understanding that it is difficult to decide in a free society how far threats should be applied to control behavior. A student panel should be organized to discuss, "Should people be allowed to demonstrate against conditions which they feel are injust?" ("What is the difference between a demonstration and a riot?")

After the discussion the class might invite a lawyer and a police officer to explain the actual laws concerning demonstrations and the problems connected with enforcing them.

5.9 Intersystem Analysis: Organizations and Structure

5.91 Understanding the functioning of an organization. Divide the class into three committees whose purpose is to investigate the functioning of the space program.

Committee 1 should investigate and report why the space program is an organization. Their report should bring out the fact that it consists of two or more subsystems joined together to accomplish the task of sending a man to the moon. This committee should list specialists in the space program and mechanical subsystems which have been working together to do the job.

Committee 2 should report on the importance of communications and the systems that are involved in communications between astronauts and earth stations. They should break down the process of these communications into five elements:

a) the origin of the communication (source);

b) how the communication is expressed (encoding);

c) how the communication moves from the space station to the spaceship (medium);

d) how the astronauts detect that a message is coming to them (detection); and

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e) how they are capable of understanding the message (decoding).

The committee should also act out a sociodrama showing the tragi-comic situations that might arise between the sources of the message and the receivers.

Committee 3 should report on the types of transactions which go on in the space program. Examples might include: the various transactions between the space agency and universities, various scientists and engineers, individual factories, etc. Students should identify examples of selfish transactions, such as North American's contract with the space agency; generous transactions, such as one astronaut helping another to shave; and hostile transactions, such as a congressman's opposition to the space program or his attaching a relatively low priority to continuing it.

5.92 **Understanding varieties in types of organizations.** Have students match the type of organization on the left with the goal of the organization on the right.

Organization	Goal of Organization
1) grocery stores owned by and run for its members	a) for its own members to produce things for themselves (cooperative)
2) supermarket	b) for its members to produce things for others with compensation (profit)
3) volunteer fire department	c) for its members to produce for others without compensation (service)
4) labor unions	d) for its members to improve their bargaining position (pressure groups)
5) Salvation Army	
6) school	
7) Democratic Party	
8) government health insurance program for the aged	

The above activity may be reinforced by having some students act out short scenes depicting each of these organizations, and the rest of the class identify the type of organization being represented. Students might act out members of the Salvation Army collecting money during the Christmas season, a labor union picket line outside a factory, or a political party candidate delivering a speech during an election campaign. Another episode could show a sick man leaving the hospital without paying his bill, since he has proved that he is over 65 and therefore eligible for the government health insurance plan. A scene in the volunteer fire department might show volunteers discussing

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their regular jobs. Another scene might depict a grocer explaining the reasons why business was bad this year or members of a cooperative dividing up its surplus at the end of the year.

5.93 Understanding how an organization can function in a selfish, generous, or hostile manner. Have students play a grocery store game. After completing a few transactions and figuring the income, costs, and profit, students should discuss the following questions:

1) Why does a grocer open a business?

2) How does the grocer communicate with his suppliers and his customers?

3) How does the grocer decide what he will pay for the goods and what he will charge for them?

4) How does the consumer decide how much he wants to pay for a particular item and how does he choose the store where he will shop?

5) What could be the reasons why a grocery store might expand, stay the same size, or close down?

Have the class act out how the functioning of organizations may be generous or hostile. Examples of organizations primarily engaged in generous transactions might include: a welfare agency, a humane society, VISTA, the American Civil Liberties Union, the Peace Corps, and the United Nations. Examples of organizations performing hostile transactions might include: the Hell's Angels, the Klu Klux Klan, the Mafia, and a military organization.

It should be pointed out, however, that very few organizations carry on transactions exclusively in one manner. Though one form of transaction may be its primary function, others are occasionally present.

5.94 Discovering that every system has a structure. Students should name the following organizations:

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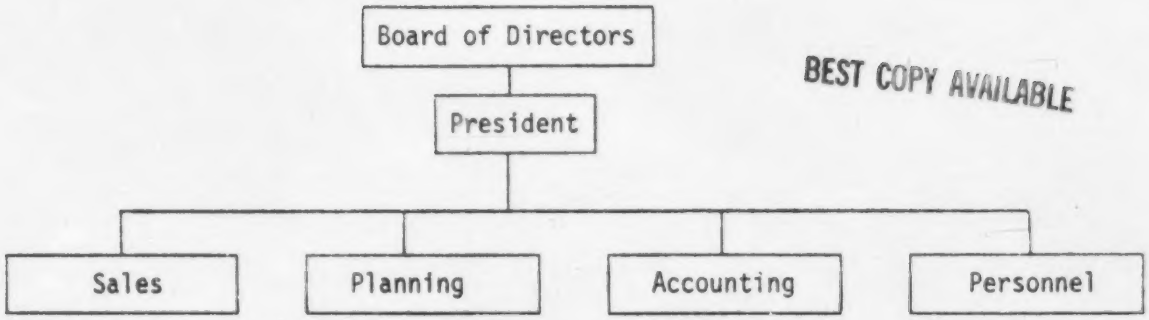
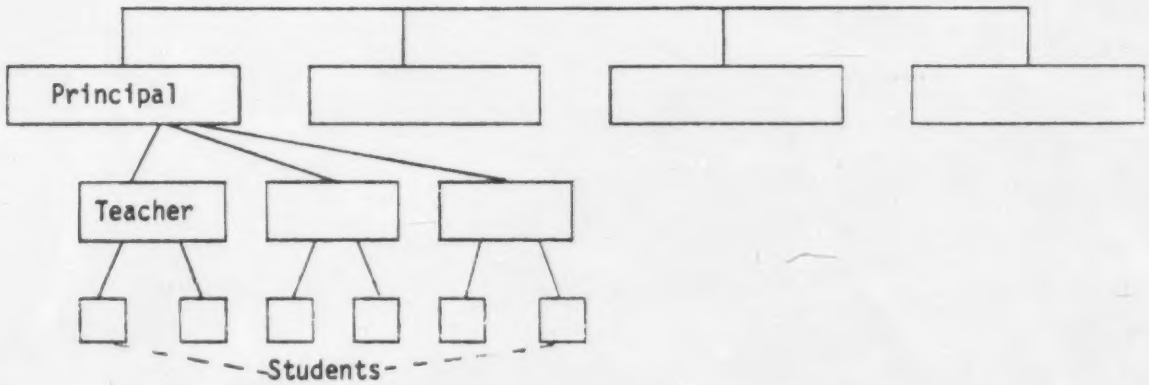


Name of Organization _____



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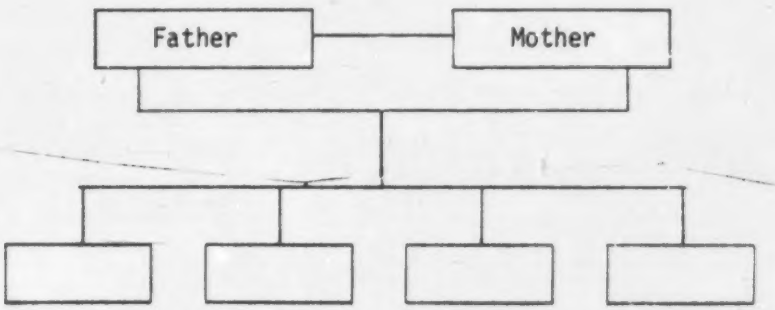

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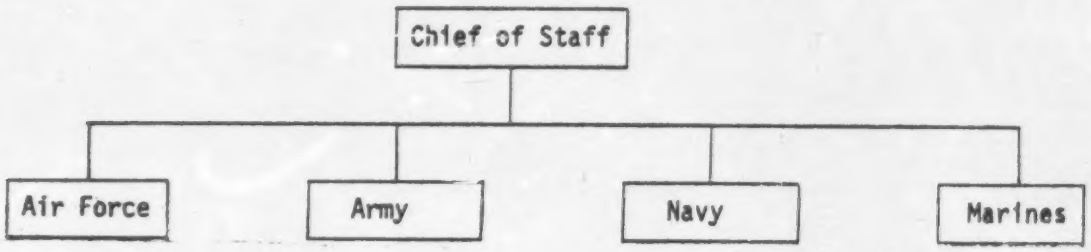

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5.95 Understanding the importance of changing the structure of a system if the goals or environment change. Students should answer the following questions:

1) How will the structure of the armed forces be affected if Congress decides to spend less money on the Navy and more money on missiles?

2) What will happen to a school system if many more people move into a neighborhood?

3) What will happen if the government decides to give everyone a higher income instead of building houses for low-income people?

4) The goal of a family used to be to produce its own food. Now that goal has changed. Why has it changed? How does this change affect the structure of the family?

5.96 Discovering the relationship between the structure of a system and its physical facilities. Students should discuss the following questions.

1) How does the "assembly line" affect the design of a factory? It should be pointed out that the factory must be built in a certain shape to accommodate a particular type of assembly line.

2) How does the law which gives income to old people affect the structure of the family? How does the changing structure of the family affect the size of its house?

3) How does the invention of big machines affect the structure of a textile production system? How does the changing structure affect the design of the factory?

4) How do the laws which give income to poor people affect the structure of churches and other institutions that give aid to the poor? How does the changing structure of churches affect their physical facilities?

5.(10) Change and Equilibrium

5.(10)1 Understanding the meaning of equilibrium. The class should discuss systems which remain the same or appear to balance, such as a seesaw, a mobile, an old-fashioned scale, or a refrigerator that turns on to re-establish equilibrium when the door is opened. A coin balanced on its edge may be seen as an example of an unstable equilibrium. For contrast, ask the class, "What are some things that are not in equilibrium?" Once the principle of equilibrium is understood, it can be applied to social systems. For example, when family income equals expenses, its budget is in equilibrium. If the number of people born each year is the same as the number who die,

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then the population is in equilibrium. If no new ideas requiring new words enter a culture, and if new words are not coined for old ideas, then the vocabulary of the language is in equilibrium.

5.(10)2 Understanding the difference between static equilibrium and dynamic equilibrium. Ask the students the following questions:

1) Is a book resting on a table in equilibrium? Why? The answer should bring out that the force of gravity counteracts the mass of the table, thereby placing the book in equilibrium.

2) If the level of a river remains four feet high, does this mean that the water is standing still? It should be pointed out that the input and outflow are even. Thus, this is an example of dynamic (or steady-state) equilibrium. The concept of dynamic equilibrium is most important in man-made systems.

3) If a family remains the same size (four members) for five years in succession, is it in equilibrium? Could it be a static equilibrium? Could it be a dynamic equilibrium?

5.(10)3 Understanding dynamic equilibrium. Bring in stock or commodity exchange quotations from the newspaper. Have the class act out an auction on the commodity exchange showing how an equilibrium has been established.

Students should discuss the following questions:

1) If in one year a city has a population of 10,000 and the next year it still has a population of 10,000, does this mean that no one was born and no one died or no one moved in or out?

2) If the price of wheat does not change, does this mean

a) that no one is buying wheat?

b) that the number of buyers remains the same?

c) that the buyers are always the same?

5.(10)4 Discovering that in a social system, custom (inertia) plays an important role in keeping the system in equilibrium. Ask the following questions:

1) How does the habit of drinking coffee affect the stability of income of coffee producers and the coffee industry?

2) How does the tradition of commitment to a time schedule affect the level of output of a business?

3) How does the custom of "keeping your word" affect the equilibrium of a family?

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4) How does the custom of a family's resisting change enable its members to predict what will happen in the future?

5) How does the custom of seniority in Congress or in business affect the equilibrium of the organization?

5.(10)5 Understanding that some cultural systems are open and others are closed. Students should compare the life of an Amish family with their own. They should do research to find out how the Amish, through their isolation, keep out new ideas. Some of their findings might include the following: many Amish children go to Amish schools; many Amish families do not use electricity, automobiles, or other modern machinery. The class should discuss how such traditions help the family to think alike, act alike, and remain the same.

The class should then discuss how in their own families, TV, newspapers, experiences in cities, schools, and reading bring new ideas into the family every day; how these new ideas make the members of the family act and think differently from one another; and how the whole family makes changes.

As a followup activity, students may browse through old issues of National Geographic to find pictures of people who are isolated from other cultures. Then they should discuss the possible reasons for and consequences of a closed system. What are the benefits? What are the drawbacks?

5.(10)6 Demonstrating how and why change occurs in systems. Pose the following questions:

1) What will happen if a big corporation comes to a city? How does this affect other systems and what adjustments must be made to make the city a pleasant place in which to live?

2) What would happen if a river floods a city? How does this affect the various systems in the city?

3) What will happen if the size of families increases? decreases? How do these changes affect the school system? the housing system? and the business system?

5.(10)7 Discovering that man is always trying to improve systems. Have students prepare a display showing how man has improved his transportation system from horse-drawn carriages to cars and his school systems from one-room schoolhouses to big, consolidated schools. The display could also show how big corporations have replaced small businesses and how cities have replaced villages.

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It should be pointed out that not all changes are improvements: what is lost when a small school is consolidated? when a big corporation replaces small businesses? when a town grows into a city?

5.(10)8 **Discovering that in the process of creating or changing systems, benefits or costs to society may be created.** The class should collect newspaper articles illustrating such relationships. For example, "Congress Votes Law to Control Floods and Use the Power of the Tennessee River," "Government Approves Plan to Drill for Oil in Arctic Alaska," "Steel Mills Pour Wastes into Great Lakes," "Dry Grazing Land is Plowed in the Great Plains," "Grand Canyon is Flooded to Build Dam for Power," "New Freeways Will Cut Through Center City," "Oil Leaks Off California Coast," "Billboards Approved in Yellowstone National Park." After discussing what social benefits or costs are brought about by these systems, students should consider who ought to pay the costs and how money can be collected from those who benefit from these systems.

5.(11) Analyzing Students' Daily Lives Using Systems Concepts

Discuss the following questions, using principles of system analysis.

1) Are you better off if other people like you than if they dislike you? Why? Answers might include the following points: if people like you, you will tend to receive more of the things you value and which they have through generous transactions. Your bargaining power will therefore be greater.

2) If you think it is useful to be liked, do you think it is more important to be liked by your teacher, your classmates, the principal of your school, your mother, a policeman, others? Why? Answers might include the following points: being liked may be a thing one values highly. It may also be more important to be liked by one person than by another. If one expects to receive valued things as a result of being liked, then it might be more important to be liked by those who have the things you value most.

3) Does the principal have the power to suspend you from school? Do you have the power to suspend him? What kind of power is he able to exercise over you which you are not able to exercise over him? Do you think such an arrangement is sensible? Answers might include the following points: the principal has more absolute power, and with this power he can suspend the student. The principal is a member of an organization which can be called upon to support his authority. He also has the ability to call upon the school

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board and the police to support his position.

4) Are there any bullies in your class? What kinds of power do they use to make others do what they want? Can your teacher stop them? Can you or other people stop them? Answers might include the following points: bullies can use threats or stress to increase their bargaining power. The teacher can sometimes exercise greater power than the bully. Several students can join together to form a coalition which has more power than the bully.

5) If you are black and your teacher is white, what kinds of things about you do you think he is able to understand? When you talk, can you understand others of the same race better than those of a different race? Why? Answers might include the following points: the teacher is more likely to understand you if you encode and decode communications in the same way as the teacher. People from different cultures vary in the way they encode and decode and these differences sometimes interfere with communication.

6) What kinds of things do you learn about best from your parents? Your teachers? Others your own age? Others a little older? Others a little younger? From reading? From TV? Would you like to change any of these things? Answers might include the following points: from various individuals and groups a person receives information about the environment; acquires parts of the culture in which he lives, such as language, knowledge, values, and beliefs; and is socialized in various ways. Each source varies in the quantity and quality of information it imparts.

7) If your classmates come to you for advice, does this make you feel good? If so, do you expect them to do anything for you in return? Do you learn anything while you are giving them advice? Would you rather give advice or recieve it? Answers might include the following points: If a classmate seeks your advice it means you have something he wants; therefore your bargaining power with that person has been increased. You may also value being asked for advice.

8) Do you think there is anything your teacher could learn from you? What? If so, why do you think your teacher doesn't know these things? Answers might include the following points: the teacher could learn the language, knowledge, and values of your subculture, which he may not know because he has not been exposed to the same environment.

9) On the playground, Alice and Carol have an argument about the proper rules for playing hopscotch or some other game. Carol wins the argument

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and Alice accepts Carol's rules. What are the reasons why some people win and others lose arguments? Answers might include the following points: some people, through the use of tactics and strategy, have more bargaining power. They may also have something that another wants badly enough to give up or to lose a particular argument. They may also be better informed, or simply talk with more assurance.

10) Do you ever have difficulty understanding the student next to you when he speaks? a radio announcer? What could be done to make it easier for you to understand? Answers might include the following points: understanding may be hindered by improper encoding or decoding. To aid understanding, one might ask the fellow student to speak more clearly or loudly. One could also observe other forms of communication, such as lip movements and gestures. The volume could be adjusted on the radio and the station tuned in better so that the announcer could be understood better.

11) What would you most like to do after school this afternoon? Do you suppose you learned to want to do it, or that you were born with the want? Do you think that you will actually be able to do it? If not, would the behavior of other people have to change before you would be able to do it? Do you have any power to make them change? Would you yourself have to change? Are you able to bring about any of the necessary changes in your position? Could your teacher help you to change? Do you think he would? Answers might include the following points: what a person wants to do depends on the values he holds--the selector function. Whether he can do something depends partly on his ability to do it--the effector function. Getting others to help depends on both communications and transactions with others. In addition, what he wants depends on either learned or unlearned needs. Wants and the ability to satisfy those wants can be changed through new learning.

12) If you would like to exchange things with others of your own age, like stamps or trading cards, do you think you would be better off exchanging with someone who has many of these things or someone with only a few (assuming they both want what you have to trade?) Why? Answers might include the following points: you would probably be better off exchanging with someone who has more of the things you want, since he would probably value a single item less and be more willing to give it up. This would increase your bargaining power so that you could acquire the item under more favorable terms.

13) Suppose you are a better-than-average ball player for your age

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and would like to get into a game that needs another player. Would you be more likely to be allowed to play the position you like most on the team if you are really eager to get into the game, or you don't really care very much whether you get into the game or not? If you really do want to play, would it help you to be able to play the position you want if you pretend you don't really want to get into the game very much? Answers might include the following points: you would probably have more bargaining power to get the position you want most if you don't show how strongly you want it. The team may be more willing to give you the position in order to have you as a member of the team. On the other hand, they may value your services more highly if they also value your eagerness to be a member of the team.

14) If you observe another student doing something you think the teacher would like to know about, what would you gain by telling the teacher? What might you gain by not telling the teacher if the other person knows you observed the act and doesn't want the teacher to know? Answers might include the following points: you may gain recognition from the teacher and may increase your bargaining power in future transactions with him. On the other hand, you have weakened your future bargaining power with the other person. If, however, you don't tell the teacher, you can use your knowledge to increase your bargaining power and thus get things you value from the other person.